KENNECOTT

M/035/009

BARNEYS CANYON MINE
P. O. BOX 311
8200 SOUTH 9600 WEST
BINGHAM CANYON, UTAH 84006-0311
TELEFAX NUMBER (801) 569-7190

CONFIDENTIAL NOTICE

SENDER: S. Lackey **PHONE NO:** 569-7131

TIME: 4:45 **DATE** 10/29/93

TO: Holland Shepherd

LOCATION: DOGM **FAX NO:** 359-3940

FROM: SD Lackey

LOCATION: BARNEYS CANYON MINE

NUMBER OF PAGES (INCLUDING HEADER): 12

COMMENTS: Permit Applications (Sludge)

Barneys Canyon Mine
8200 South 9600 West
P.O. Box 311
Bingham Canyon, UT 84006-0311
(801) 569-7000

Kennecott

October 5, 1993

Ms. Lisa Rogers
Division of Water Quality
288 North 1460 West
Salt Lake City, Utah 84116

Dear Ms. Rogers:

Please find enclosed the Barneys Canyon Mine, Proposal for the Land Application of Sludge for Mine Reclamation. In reference to our discussion following the DOGM meeting in Salt Lake City on September 28, we would appreciate your assistance in providing a timely review and response. Our objective is to achieve approval in time to proceed with testing this fall. Thank you for your assistance and please advise if additional information is required.

Sincerely,

S. D. Lackey
HSEQ Supervisor

attachment

cc: D. I. Hodson
C. S. Emmons
H. Shepard (DOGM)

October 5, 1993

Ms. L. Rogers
Department of Water Quality

Dear Ms. Rogers:

With regard to existing and forthcoming reclamation trials at the Barneys Canyon Mine, mine management, with consultation assistance from Steffen, Robertson and Kirsten (U.S.), Inc. (SRK) wishes to determine the effect of municipal sludge applications on the overall fertility of waste rock, and resultant vegetation performance. Therefore, SRK, on behalf of Barneys Canyon Mine, is submitting a description of current and proposed reclamation trials work at the Mine, within which sludge applications are anticipated. We trust that the information provided below is sufficient for you to grant permission for applications to proceed this fall.

This submission relates to two experimental field trials designed to determine the effects of topsoil cover and varying fertilizer amendments on the performance of a commercial vegetation mixture, for waste rock rehabilitation. The design and purpose of these trials are summarized in this submission.

1. Existing Waste Rock Field Trials

Figure 1 describes the structure of an existing trial of 2.6 acres surface area, located on a more or less horizontal bench of waste rock, at the Barneys Canyon open pit.

The chemical and physical characteristics of the waste rock and the topsoil used in blocks B1 and B2 are described as follows:

Topsoil

Harker and Dry Creek topsoil from stockpile E (E 7000/N 30 000) was used for the cultivation of vegetation cover on selected areas of the bench. Approximately 33% of the horizontal surface remained uncovered by topsoil, to determine the effect of direct seeding into amended waste rock material. A number of chemical and physical factors are expected to limit plant growth and establishment on both the topsoiled and bare waste areas. In order to calculate the requirement for chemical and physical amendments appropriate for both topsoil and waste material, a formal analysis of materials characteristics was performed. A summary of Harker and Dry Creek soil chemistry is shown in Table 1.

TABLE 1
CHEMICAL CHARACTERISTICS OF HARKER & DRY CREEK SOILS
(All measurements shown as mg/kg dry mass, unless otherwise indicated)

Variable	Median	Range	Requirement for Normal Plant Growth
pH	6.89	6.55 - 7.28	4.5 - 8.0
CEC (me%)	24.5	17.7 - 26.6	10.0 - 20.0
Organics (%)	1.64	1.31 - 3.75	1.0 - 3.0
Nitrate (mg/kg)	1270.0	990.0 - 1400.0	15.0 - 20.0
P	4.9	1.9 - 11.7	2.0 - 20.0
K	552.0	184.0 - 588.0	100.0 - 300.0
Ca	1210.0	1020.0 - 1370.0	500.0 - 2000.0
Mg	359.0	349.0 - 809.0	50.0 - 100.0

Physical analysis of the soils indicated that the material is free draining. However, soil texture reported in the existing reclamation plan states that Harker - Dry Creek topsoils have a significant clay content. The soils are dolomitic and base saturated.

Generally, the soils contain sufficiently high concentrations of macronutrients essential for maintenance of established vegetation cover. For the purpose of increasing the probability of success in initial plant growth and cover establishment, the nitrate concentrations measured in the topsoil will be regarded as transient, and in need of supplementation by commercial nitrogen addition. Although adequate for maintenance of established vegetation, the phosphorus levels in the soil will have to be raised slightly to promote root development and establishment of nitrogen fixing species (legumes).

Waste Rock

Analyses of waste rock at Barneys Canyon show the material to be predominantly coarse dolomitic sand which comprises the following approximate particle size distribution:

- cobbles - 13%;
- sand & gravel - 51%; and
- fines - 36%.

Generally, 100% of the material is able to pass through a 3" mesh.

Chemical analysis of the waste indicates a relatively low heavy metal content which is not expected to limit direct vegetation establishment. The Barneys Canyon waste is reported not to contain sulfidic, acid - generating residues. This is confirmed by the following leachate analysis:

- pH - 6.44;
- Ca - 131 mg/l;
- Mg - 54.9 mg/l;
- Na - 2.9 mg/l; and
- K - 1.37 mg/l.

Analyses of diamond drill core samples of ore from the Barneys Canyon pit also provide supporting evidence of an overall net neutralization potential within the rock matrix:

- pH - 8.9;
- NP - +563;
- AC - -7;
- ABP - +556; and
- Classification - Non Toxic.

Results of a thorough analysis of metal concentrations in the dolomitic waste rock being placed on the step have been reviewed. These do not indicate any inherent limitations to the direct establishment of vegetation into appropriately amended waste rock. Chemical analyses of the sandstone wastes have not been performed. In this context, chemical toxicity is not expected.

Field Trials Design

The trials aim to optimize waste rock amendment and seeding strategies to promote rapid establishment of vegetation cover, using minimum chemical and physical site preparation. To this end, the effects of varying topsoil depth and commercial fertilizer applications on the growth and establishment of an appropriate mixture of commercial species will be evaluated.

The trial will determine the significance of the effects of topsoil and fertilizer treatments upon the germination, growth and establishment of a selected mixture of commercially available grass and forb species. A total of 12 treatments are being assessed, and comprise three topsoil depths, four fertilizer regimes and their interaction. ~ which area is this ?

The topsoil depth varies from zero to the DOGM requirement of 12". Therefore, the entire surface area of the bench has been divided into 3 equal blocks which will receive:

- zero topsoil;
- 6" topsoil; and
- 12" topsoil.

Each of the 3 blocks should, subsequently, be divided into a further 4 subdivisions. Each subdivision will receive a single fertilizer application from the following set:

- specification NOI 89;
- specification NOI 92;
- specification SRK 92; and
- zero fertilization control.

Each of these fertilizers is being evaluated within each topsoil block, according to the plan described in Figure 1. This allows for convenient placement of topsoil in a systematic way, but with randomized allocation of fertilizer treatments to partially overcome water gradient effects from the highwall to the crest berm.

Fertilizer specifications

The NOI 89 and 92 specifications are derived from the recommendations contained in the Barneys Canyon Reclamation Plans, NOI 89 and as amended in NOI 92. The SRK formulation has been calculated according to results of chemical analysis of soil and waste rock.

Specifically, the formulations include:

NOI 89

- green alfalfa mulch at 4000 lb/acre; and
- compound 18-46-0 at 310 lb/acre.

3 x 4 = 12 ~~plots~~ sub-plots or treatments

NOI 92

- green alfalfa mulch at 2000 lb/acre; and
- urea at 45 lb/acre.

SRK 92

- alfalfa, straw or wood fibre mulch at 2000 lb/acre;
- ammonium nitrate at 135 lb/acre; and
- triple superphosphate at 180 lb/acre.

Control

- no mulch or fertilizer application.

Species Selection

Due cognizance was taken of the species recommended for vegetation establishment on topsoiled and non-topsoiled areas, in the NOI 89 and NOI 92 reclamation plans. Whilst in general agreement with these specifications, SRK proposes a modified mixture to fulfill the following requirements:

- rapid establishment of a temporary "nurse" crop of one grass and one legume species;
- establishment of a more diverse cover of native and naturalized grass and forb species; and
- the development of a root architecture and surface cover to fulfill the design criteria for optimally erosion resistant covet.

The proposed species mixture contains annual and perennial species of grasses and forbs which are variously sod-forming, bunch-forming, laterally-spreading or deep rooting. The varieties of each species have been selected for tolerance of the relatively stressful environmental conditions which prevail at the mine. A full description of the species and their application rates is shown in Table 2.

TABLE 2
SPECIES OF GRASSES AND FORBS SELECTED FOR RECLAMATION TRIALS AT BARNEYS CANYON MINE

Botanical Name	Variety	Common Name	Growth Habit	Application Rate lb/acre
Agropyron smithii	Boston/ Rosana	Western wheatgrass	Perennial/ sod forming	5
Agropyron spicatum	Secar	Bluebunch wheatgrass	Perennial/ bunch	4
Festuca ovina	Covar	Sheeps fescue	Perennial/ bunch	2
Elymus elymoides		Squirrel tail	Perennial/ bunch	2.5
Poa canbyi	Canbar	Canby bluegrass	Perennial/ bunch	1
*Secale cereale**		Cereal rye	Annual/ nurse	4
Astragalus cicer	Lutana	Cicer milkvetch	Perennial/ rhizomes	3
*Melilotus officinalis**	Yukon	Yellow sweet clover	Short-lived biennial	1
Medicago sativa	Vernal	Alfalfa	Perennial/ deep-rooted	2
Penstemon palmeri	Cedar	Palmer penstemon	Perennial/ sod forming	1

* Temporary "nurse" cover.

All application rates have been calculated for drill seeding. Any broadcast method of seeding, including hydraulic placement, will require double the prescribed rates.

Results To Date

Following late spring seeding in 1993, effective vegetation cover has established on topsoiled plots, particularly where soil has been fertilized with the NOI 89 and SRK 92 mixtures. However, the vegetation cover is predominantly composed of ruderal species, to the exclusion of commercial grass and legume cover. Conversely, the vegetation cover established directly into waste rock, without topsoil cover,is composed exclusively of commercial grass and legume species. The commercial cover is sparse, and its distribution pattern indicates water availability as a likely limiting factor. The surface of the waste rock is compacted and cemented, leading to runoff and reduced infiltration.

Proposal

Given the frequency and condition of commercial grasses and legumes which have established successfully on the waste rock, without topsoil, the prognosis for developing a more extensive vegetation cover on waste which has been appropriately "conditioned", is excellent. Therefore, it is proposed that the existing non-topsoiled sections of block B3 are split, with one-half of each to remain untreated and the other half to be conditioned with municipal sludge. The following strategy is proposed:

- Cells C1-C4 are to be disced or harrowed to break the compacted and cemented surface;
- 50% of each cell is to be conditioned with 10t/acre municipal sludge (source - Central Valley WTP);
- Sludge should be incorporated to a depth of 6 inches, if practically possible;
- The entire B3 block is to be reseeded and mulched, using the previously described seed, mulch and fertilization scheme.

It is anticipated that sludge conditioning would take place in the fall of 1993. Ideally, hydraulic or drill seeding would follow immediately. In the event of unforeseen delays, sludge applications would proceed at the earliest convenience, before winter snowfall, followed by early spring seeding.

Due cognisance has been taken of the chemical and biological characteristics of the sludge. A summary of the results of chemical and biological analyses performed by Central Valley WTP is given in Table 3. Barneys Canyon Mine management does not envisage any impact of the sludge application program on groundwater quality, given the location of the existing trial.

2. Proposed Waste Rock Field Trials

Existing trials at Barneys Canyon Mine involved vegetation establishment on more or less horizontal waste rock surfaces. However, a number of areas to be vegetated in the mine reclamation program are concerned with vegetation establishment on rock dump slopes. This poses several logistical problems with regard to accessibility, surface treatment incorporation and seeding. Consequently, SRK and the Mine have commenced construction of experimental field trial plots on the north- and south-facing slopes of the 6400/6500 waste rock dump. This dump is chemically similar to the waste rock characteristics described in Table 1.

It is proposed that field trials to determine the effect of slope angle and aspect, and topsoil cover, on the growth performance of a standard mixture of plant species is investigated. Additionally, the effect of slope angle on topsoil erosion should be assessed. Where vegetation is to be established into waste rock without topsoil cover, the waste rock surface should be amended with municipal sludge.

The north and south facing slopes of the 6400-6500 west waste rock dump are appropriate for this work. The experimental design involves the construction of an 8 block trial area, comprising:

- surfaces with and without topsoil, on
- north and south facing aspects, at
- angle of repose slopes and regraded slopes at 2.0:1.

The conceptual layout of this trial is shown on Figure 2.

The four blocks on both north and south facing slopes should be approximately ¼ acre surface area each, demarcated and labelled appropriately. Slope regrading and surface preparation have already been completed in time for fall seeding, in October.

Surface Preparation

The surface of each block should be scarified laterally. Scarification can be achieved by ripping the surface horizontally at 6 inches to 12 inches depth, with 12 inch spaces between blades. If this is not practically possible, the final, topsoiled surface should remain rough and uncompacted.

In accordance with procedures set out in NOI 1989, as amended 1992, selected blocks will be topsoiled with approximately 12 inches of topsoil. Others will be amended by application and incorporation of sludge, at a rate of 20t/acre.

Fertilization

On the basis of results recorded to-date, from field trials performed at the Barneys Canyon Pit, the use of a compound 18-46-0 fertilizer is appropriate. An application rate of 310lb/acre is

recommended on the assumption that the chemical and physical properties of the waste rock and topsoil are similar to those at the existing Barneys Canyon Pit trial.

Seeding

As a consequence of slope angles and slope lengths, hydraulic seeding and hydromulching are most appropriate. The seed mixture will be the same as that used in the existing trial at Barneys Canyon, as described in Table 2.

Erosion Protection

Given the slope angles upon which vegetation is to be established, silver fiber mulch and a plantago gum tackifier will be used to stabilize all surfaces. Because of the hydraulic seeder pumping limit of 4% suspended solids, it is necessary to hydromulch the seeded area with fiber mulch and tackifier as a separate application, immediately following seeding. Recommended application rates are:

- Silver fiber - 2000lb/acre
- Plantago gum - 100lb/acre

Operations Summary:

July 1993

Block demarcation and identification
Surface regrading
Scarification/ripping at 6 inches
Topsoiling/ripping

October 1993

Municipal Sludge application @ 70t/ac
Hydraulic seeding with:
- compound 18-46-0 @ 310lb/acre
- seed mixture @ 51lb/acre

Hydromulching with:

- silver fiber mulch @ 2000lb/acre
- plantago gum @ 100lb/acre

The municipal sludge will be obtained from Central Valley WTP, and the biochemical profile given in Table 3 will apply. As a consequence of the rockiness of the waste rock at the 6400/6500 dump, a higher sludge application rate than that prescribed for the bench trial, previously described, is recommended. Mine management does not anticipate any negative impact of this trial application program on ground waster quality.

We trust that this information is adequate for your review and consideration of permitting sludge application on each of the trial areas. Should you have any queries in this regard, please contact us at your earliest convenience.

We look forward to your reply.

Yours Sincerely,

D.I. Hodson
General Manager
Barneys Canyon Mine

DH:sjl

Attachments

TABLE 3

Report No. 11
01-May-93 01-Sep-93 00:00:00

DRY BELT FILTER PRESS CAKE HEAVY METAL DATA

Date	Al ppm	Ag ppm	As ppm	Ba ppm	Be ppm	B ppm	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe ppm	Hg ppm	K ppm	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	Se ppm	Sn ppm	Ti ppm	Tl ppm	V ppm	Z p
3/May/93		100.0	9.5	724.1		60.9	8.6		70.1	584.9		0.6		187.3	40.2	50.8	234.5		35.8	10574.0			13.6	97
5/May/93		103.3	8.2	850.3		51.1	6.5		65.2	498.3		2.6		170.1	39.1	61.9	243.0		30.5	9130.4			21.2	99
8/May/93		87.1	10.8	782.4		91.2	5.9		70.0	800.1		1.8		204.7	43.5	71.2	328.8		27.5	88940.8			18.8	10
4/May/93		118.0	3.6	834.3		58.4	8.1		75.7	835.3		3.1		218.8	42.5	84.6	318.8		37.6	15192.9			19.9	11
1/Jun/93		94.9	5.3	740.2		42.9	6.8		65.5	533.9		3.6		192.1	47.4	59.3	338.1		33.7	22789.0			20.9	10
7/Jun/93		106.7	6.6	768.7		62.2	5.8		65.5	566.7		4.3		208.9	42.6	61.7	259.9		31.2	10532.8			17.6	98
4/Jun/93		103.4	8.4	864.4		58.5	9.0		79.9	615.8		3.8		261.8	42.9	85.8	264.4		37.4	97358.7			19.8	12
1/Jun/93		105.9	8.1	801.0		51.6	7.0		78.3	612.9		3.2		298.4	37.8	71.0	230.0		28.4	9978.8			21.0	10
9/Jun/93		84.7	6.1	788.2		48.2	8.2		85.3	652.9		1.8		301.2	45.9	90.0	237.3		19.9	18411.1			20.0	10
1/Jul/93		102.8	5.7	792.2		41.0	7.9		72.5	623.2		2.4		340.5	35.9	82.0	225.3		17.2	18315.0			19.7	10
3/Jul/93		73.3	Over Ran	593.1		54.1	4.7		58.1	456.3		1.5		298.2	51.7	83.6	188.5		28.8	14243.8			18.0	91
7/Jul/93		87.2	7.4	535.5		39.9	5.5		55.7	409.8		1.7		295.1	47.5	55.2	134.2		29.3	15026.6			19.1	84
1/Jul/93		62.0	10.3	453.4		37.1	7.5		42.8	377.6		4.1		279.7	49.7	72.7	138.0		32.8	13262.6			17.7	74
3/Aug/93		89.7	7.7	711.9		62.6	8.7		78.6	576.1		2.4		445.9	49.5	75.0	145.7		28.8	15597.3			22.3	87
5/Aug/93		93.0	3.8	712.8		73.3	8.7		71.3	569.3		2.9		442.8	49.7	77.4	125.1		18.4	12815.6			16.9	69
1/Aug/93		80.5	7.1	741.4		57.1	4.6		85.8	603.4		2.1		509.2	47.7	81.6	140.2		18.1	7149.4			24.7	10
7/Aug/93		80.3	8.8	734.2		79.9	11.7		58.6	534.5		0.5		443.9	47.7	129.2	140.2		Under Ra	1149.4			21.2	12
AVE		90.8	6.8	717.2		58.5	7.1		69.7	550.2		2.8		296.5	44.8	72.1	212.5		28.0	13730.9			19.2	93
MAX		106.0	10.8	864.4		91.2	11.7		85.8	652.9		4.3		509.2	51.7	129.2	328.8		43.6	22789.0			24.7	12
MIN		60.3	3.6	453.4		32.1	4.6		42.8	377.6		0.5		170.1	33.9	50.8	125.1		16.4	1149.4			13.8	74